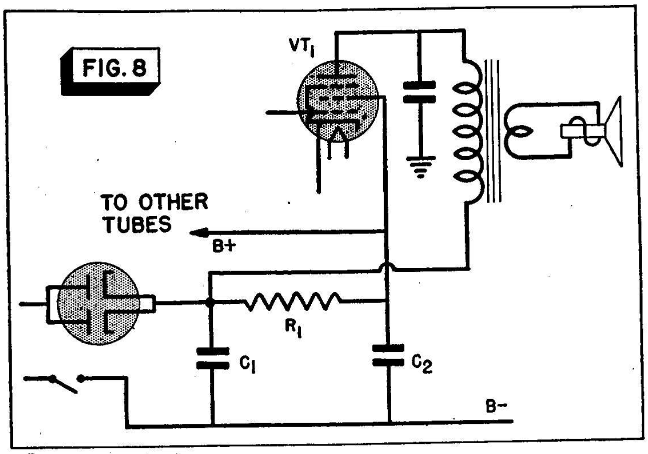
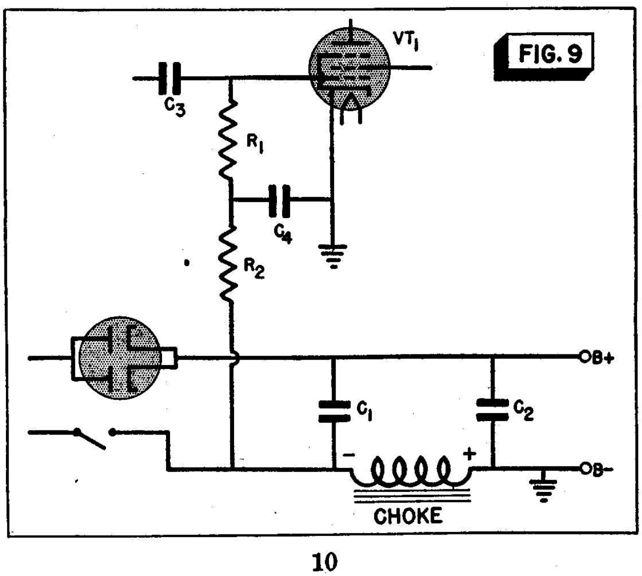
No. 30 How To Service A.C.-D.C. Receivers

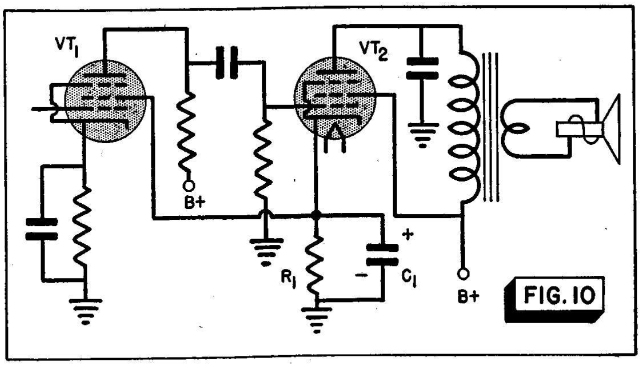
RADIO SERVICING METHODS



ity, making it better able to pass the high current that flows when the set is first turned on.

► A few a.c.-d.c. receivers use a resistor in place of the filter choke, as shown in Fig. *8*. (In modern receivers using this circuit, the speaker is invariably a p.m. dynamic.) The resistance of R_1 must be at least 10 times the reactance of condenser C_2 to provide sufficient fil-





tering. If all the current drawn by the set were allowed to flow through the resistor, too much voltage would be dropped across it; therefore, the plate current for the power output tube VT_1, which needs the least filtering, is taken off ahead of the filter resistor. All other plate and screen-grid currents flow through R_1.

► Another possible filter variation is the use of a choke coil in the negative side of the filter circuit. The purpose is to use the voltage drop across the choke as bias for the output tube, as shown in Fig. *9*.

► The screen grids and the plates are supplied with the same d.c. voltage in a.c.-d.c. receivers, with the exception of the screen grid of a C-bias detector in t.r.f. sets. The reduced screen voltage it needs can be obtained as shown in Fig. *1*. Another method is shown in Fig. *10*, where the detector screen grid is connected to the cathode terminal of the output tube. This applies the output tube bias voltage, developed across bias resistor R_1, to the screen grid of the detector tube. As it happens, this bias voltage is about the right value for the screen voltage of this detector circuit.

It is important to recognize this last variation, because, in making continuity checks, you won't find continuity between the screen grid of this detector and B+. Instead, the continuity will be from the screen grid through the low resistance R_1 to B—. (Of course, if the speaker field is connected from B+ to B— as in Fig. *7B*, you can find continuity through R_1 and the speaker field back to B+.)

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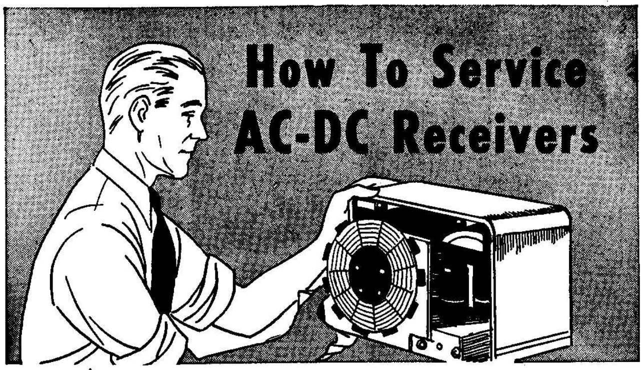


PRACTICALLY all modern midget and small table-model sets, and many of the low-priced console receivers, are a.c.-d.c. sets (able to operate from either an a.c. or a d.c. power line). Generally speaking, these sets have simpler signal circuits than standard a.c. receivers, and are inferior to the latter in selectivity, sensitivity, and fidelity. However, their compact construction and low cost have made them very popular in spite of these shortcomings.

Your earlier RSM Booklets have discussed the servicing of all kinds of receivers, both straight a.c. and a.c.-d.c. Here we are going to concentrate on the servicing problems that are peculiar to a.c.-d.c. sets, showing you what changes you must make in your general servicing procedures to adapt them for use on sets of this sort. As the first step, let's see how the circuits of a.c.-d.c. sets differ from one another and from straight a.c. sets. (This is important, because service information is frequently not available on these sets. Many are "orphans"—their manufacturers are out of business by the time they come in for servicing.) We'll start with the signal circuits.

BASIC SIGNAL CIRCUITS

Tuned-Radio-Frequency Type. Today, the t.r.f. circuit is used only in the smallest and least expensive of the a.c.-d.c. receivers. In practically all cases, this circuit uses the fewest possible parts, so that the receiver can be manufactured at a low cost.

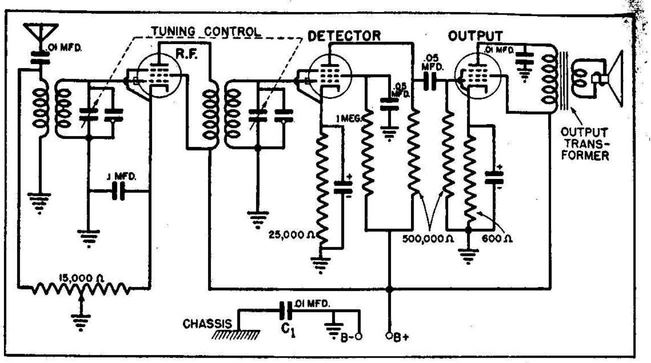


FIG. 1. Two tuned circuits are used in this typical a.c.-d.c. tuned radio-frequency (t.r.f.) receiver. To align such a receiver, simply tune in a station near the high-frequency end of the band, then adjust the trimmer condensers (mounted on the gang tuning condenser) for maximum output. The r.f. amplifier tube is usually a super-control pentode such as the 78, 6D6, 6K7, 12K7, or 12SK7. A sharp cut-off pentode is used as a detector; typical tubes are the 6C6, 77, 6J7, 12J7, or 12SJ7. The power output tube may be a 38 or 43 pentode, or a 25L6, 35L6, or 50L6 beam power tube. Some of these receivers use a magnetic speaker, connected directly in the plate circuit of the power tube, instead of the dynamic speaker and output transformer combination shown here. Notice that the volume is controlled by simultaneously varying the antenna input voltage and the C bias on the r.f. tube.

A typical circuit has one r.f. amplifier stage, a detector stage of the C bias type, and an audio output stage, as shown in Fig. *1*. The antenna usually consists of about 20 feet of flexible insulated wire which comes wound on a fiber card and is connected to the receiver input circuit through a small paper or mica condenser. This "hank" of wire should be unwound, and dropped out a window, tacked around a window, or placed under a rug. Satisfactory reception can often be obtained simply by connecting this hank to a ground.

These t.r.f. receivers are intended only for local station reception. They have little selectivity, and consequently should not be used on long antennas—also, they will overload and distort on local-station signals if the volume control is advanced too far. Also, the tone quality is not of the best. Remember these limitations so you won't waste time trying to make these sets perform like larger receivers.

A.C.-D.C. Superheterodynes. The a.c.-d.c. superheterodyne is also essentially a simple receiver. The most common kind uses 5 tubes (including the rectifier) in the basic circuit shown in Fig. *2*. Here we have a simple frequency converter, an i.f. stage, a combination second-detector-first-a.f. stage, and a power-output stage.

In the set shown in Fig. *2*, an antenna coil is used to feed the signal from the hank antenna to the control grid of the first tube. Often a loop antenna is used instead, with the loop winding replacing the secondary of the antenna coil. Some manufacturers provide a single turn of wire around the loop to be used to couple the loop to an outside aerial and ground.

► The r.f.-i.f. section of a variation of the superheterodyne circuit is shown in Fig. *3*. Notice that there is no i.f. tube, but an i.f. transformer is used to couple the first detector to the second detector. This is essentially a superheterodyne circuit, since an i.f. signal is produced. Although there is no i.f. tube to amplify this signal, some i.f. gain is provided by the transformer. More is secured by making the second detector regenerative. This particular variation makes a four-tube set. It was rather popular several years ago, so you may still occasionally get one for servicing.

► In general, the a.c.-d.c. superheterodyne has less signal output but almost as good sensitivity and selectivity as a straight a.c. receiver using a similar number of tubes. However, using an outdoor antenna with such a set may permit considerable image interference and cross-modulation to occur, particularly during the evening and in the winter months.

Now, let's turn to the power supplies, where the greatest difference between the standard a.c. and the a.c.-d.c. sets exists. The one great difference is that you will never find a power transformer in an a.c.-d.c. receiver. The power pack of an a.c.-d.c. set must rectify the a.c. line voltage and deliver the maximum possible B supply to the plates and screens of the tubes. (When the set is operated from a d.c. power line, the power pack serves only to filter out power-line noises and ripple.) Furthermore, since no power transformer is used, the filaments of the tubes must be operated directly from

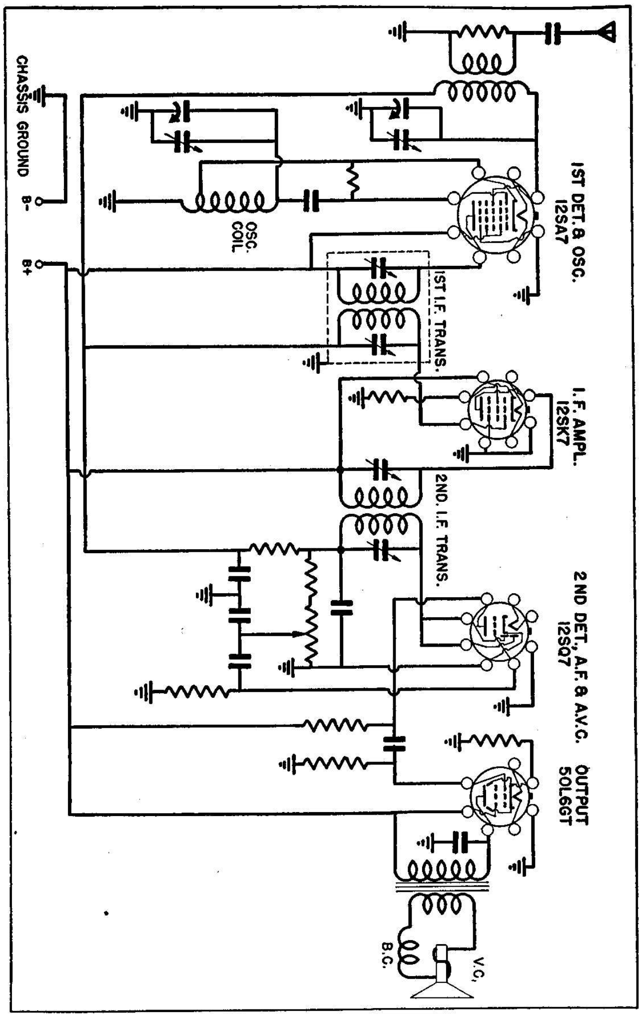
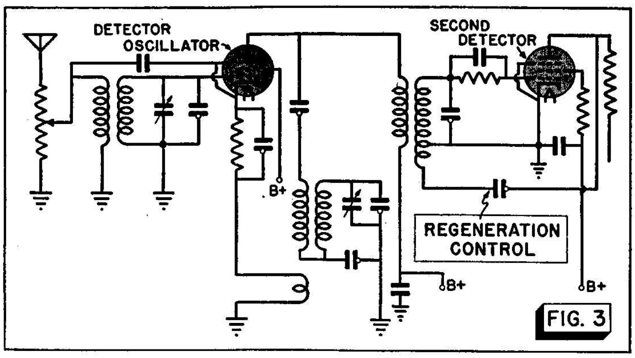


FIG. 2. The tubes used in a set of this kind depend on the age of the set. In the following, the tubes used in earlier sets are given first. The first detector-oscillator is a 6A7, 6A8, 12A8, or 12SA7. The i.f. amplifier is a super-control pentode such as the 78, 6D6, 6K7, 12K7, or 12SK7. The second detector-first a.f. tube is usually a dual-diode-triode such as the 75, 6Q7, 12Q7, or 12SQ7. The power output tube may be a type 43, 25L6, 35L6, or 50L6 tube.



the power line. Let's first see how power is supplied to the filaments, then study the plate or B power supply.

FILAMENT POWER SUPPLIES

In all a.c.-d.c. receivers, the tube filaments are operated in series so that they get their operating power directly and economically from the power line. It is standard practice, therefore, for all the tubes in any particular receiver to have the same filament-current rating.

The filament string, as it is called, consists of the tube filaments in series and whatever limiting resistor may be necessary to cause the proper current to flow. The earlier sets used 6.3-volt and 25-volt tubes rated at .3 ampere. More modern sets use 12-volt and 35- or 50-volt tubes rated at .15 ampere.

Fig. *4* shows a typical string using .3-ampere tubes. The two r.f. tubes have filaments rated at 6.3-volts, and the power and rectifier tubes have filaments rated at 25 volts each. Adding up the filament voltages, you will find that they total 62 volts. Since the line voltage is considered to be 115 volts, the difference between the line voltage and that required by the filament string is 53 volts, which must be dropped in the series resistor.

Replacing the Series Resistor. The series resistor may be a wire-wound power resistor, a ballast tube, or a special resistance element contained in the power cord. (The latter is called a Cordohm.) All types open frequently and must be replaced.

As you know, the resistance of any resistor is equal to the voltage drop across it divided by the current flowing through it. To figure out the proper resistance for a replacement series resistor, first add up the filament voltage drops and subtract their total from 115 volts. The difference is the voltage that must appear across the series resistor. Then, determine the filament current of any of the tubes in the string, and divide the value of the resistor voltage by this current value. In Fig. *4*, for example, the resistance should be about 176 ohms. Actually, a resistor between 170 and 180 ohms would be entirely satisfactory as a replacement.

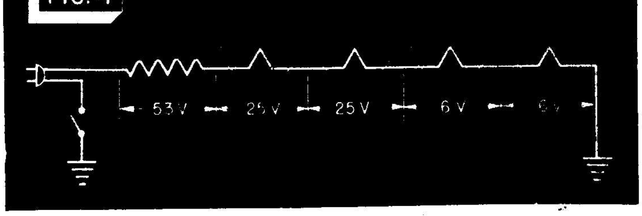
If the series resistance is a power resistor mounted on the set, its wattage must be figured carefully. This is done by multiplying the voltage by the current. The resistor in Fig. *4* dissipates about 16 watts, which means a resistor rated at about 25 watts should be used.

You do not need to figure the wattage rating of Cord-ohms; they have a standard rating of about 35 watts.

If the resistor is a ballast tube, replacement won't be much of a problem, since the ballast tubes are numbered by a system like that used for regular tubes. Simply replace the defective ballast with another having the same marking. However, some ballast tube manufacturers have their own marking codes, so you will have to refer to replacement charts issued by the manufacturer of the type you use to be sure you have the right replacement. (Incidentally, ballast tubes become very hot; always use a handkerchief or pad to pull one out of its socket.)

Low-Current Strings. Modern sets, using .15-ampere tubes, may not require any series filament resistance.

FIG. 4



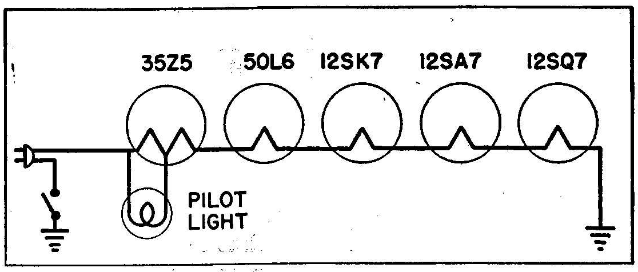


FIG. 5. Notice the arrangement of the tube filaments in this typical filament string. To prevent hum, it is desirable to have the *least* potential difference between the filament and the cathode. Therefore, the tube most likely to cause hum—the first audio tube—is always the tube nearest the ground or B— end of the filament string, because this brings this tube's cathode and filament closer to the same potential. The next tube up the string, the first detector, is the one that is next most likely to cause the hum. The high-voltage tube filaments are in all cases closest to the hot side of the power line. Of course, this means that the filament wiring must skip properly from tube to tube.

A typical string of this type is shown in Fig. *5*. Adding up the filament voltages $(12 + 12 + 12 + 50 + 35)$ gives a total of 121 volts. This string will work across the standard 115-volt a.c. or d.c. power line without any limiting resistor. The filament voltage on each tube will be slightly below its rated value, but the set will operate satisfactorily.

If a 35L6 tube is used instead of the 50L6, the voltage required by the filament string is reduced by 15 volts. In this case, a series resistor is used to limit the current to the correct value.

Pilot Lamps. Practically all a.c.-d.c. receivers use pilot lamps. A few of the very early ones used 110-volt bulbs, connected directly across the power line, but today it is standard practice to use a 6.3-volt pilot lamp in series with the tube filaments. These pilot lamps are rated at .15 ampere, or .2 ampere, or .25 ampere. To use one of these lamps in series with .3-ampere tube filaments, it is necessary to shunt it with a resistor. The value chosen for this resistor is such that the voltage across the pilot lamp will be 4.25 volts when the tubes are drawing normal current. This is done to protect the lamp against the rather high surge of current that oc-

curs when the set is switched on when the tubes are cold. The shunting resistor carries a current equal to the difference between .3 ampere and the current rating of the pilot lamp. The resistance can be found by dividing 4.25 volts by this current value.

When you replace a pilot lamp, use a 6.3-volt bulb having the same current rating as the original. The current rating is not marked on these bulbs, but it is shown by the color of the glass bead that supports the filament. In the 6.3-volt bulbs, a brown bead indicates a .15-ampere bulb, a white bead a .2-ampere bulb, and a blue bead a .25-ampere bulb.

► If the pilot lamp burns out as soon as it is installed, the wrong lamp has been used, or a circuit defect exists. The shunt resistor may be burned out, in which case the pilot lamp is called upon to carry too much current. However, if the shunt resistor is normal, and the pilot lamp is used only in series with the filament string as in Fig. *6*, then there is probably a short circuit in the filament string somewhere.

Incidentally, the shunt resistance across the pilot lamp may be a separate resistance or a section of the series resistor. If a ballast tube or a Cordohm resistor is used, it is tapped to provide the shunt resistance. If a shunting resistor of the latter sort is open, replace the entire ballast or Cordohm. However, if it is a separate resistor, or a section of a power resistor, then just the single section needs to be replaced.

PLATE POWER SUPPLIES

The B power supply of an a.c.-d.c. receiver is quite simple. There is no step-up transformer, so the rectifier

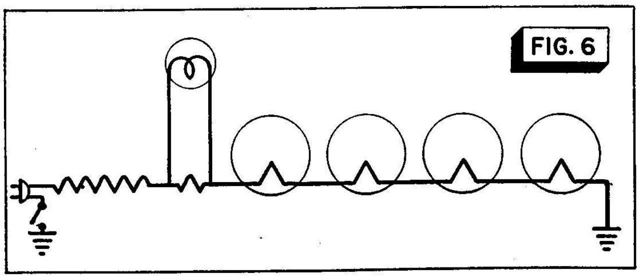


FIG. 6

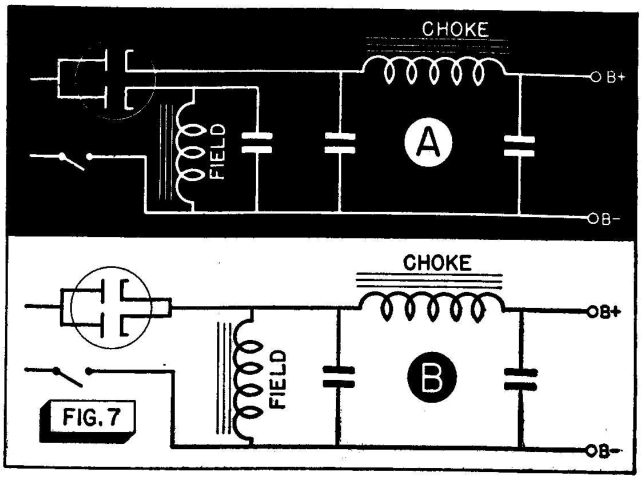


FIG. 7

tube is operated directly from the power line. The rectifier output is filtered in the usual manner, and then is used as the plate and screen-grid supply.

Some early a.c.-d.c. sets used magnetic speakers, and many modern ones use p.m. dynamics. In these sets, of course, the power supply does not have to energize the speaker field. In sets using electrodynamic speakers, there are several ways in which the speaker field may be energized. Since the rectifier output voltage is limited, a field used as a choke has to be a special low-resistance type—300 to 450 ohms—to keep the drop low.

More commonly, the speaker field is connected directly across the output of the rectifier. Some early sets use the circuit shown in Fig. *7A*, in which one cathode is connected to supply the B voltage, and the other is used to supply the speaker field. The field coil in this case is usually about 2500 ohms, and the filter condenser connected in parallel with it furnishes all the filtering needed.

Usually, however, the rectifier cathodes are tied together, and the field is connected directly across the B supply, as shown in Fig. *7B*. This connection has several advantages: it eliminates a filter condenser; there is less voltage drop in the rectifier, because its resistance is halved; and the rectifier has greater current capac-

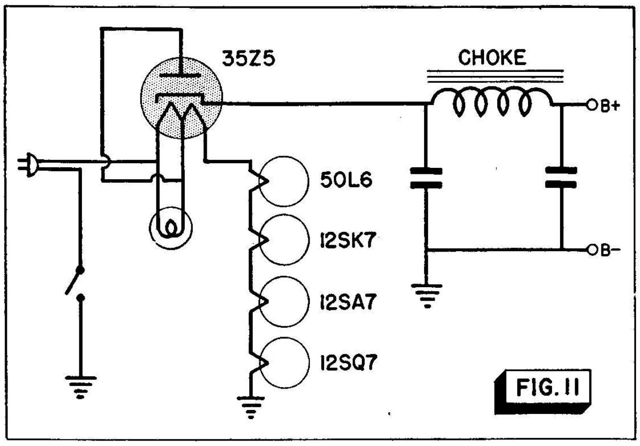


FIG. 11

► The recent a.c.-d.c. receivers generally use .15-ampere tubes and the 35Z5 rectifier tube in the circuit shown in Fig. *11*. As you will notice, the rectifier tube has a tap on its filament. This tap is arranged so that a portion of the filament can be used as a shunting resistor across the pilot lamp, and, since the plate of the tube is connected to this tap, the rectifier plate current flows through the pilot lamp and its shunting filament section. (This makes the lamp light brilliantly at first when the tube filaments are cold, dim down to a low brilliancy as the filaments warm up, then light up more brightly again as rectifier plate current flows through it.) This peculiar connection is used as a protection for the rectifier tube.

An important difference between the usual rectifier and those used in a.c.-d.c. sets is that all the latter have cathodes with links, or connectors, from the cathode to the prong lead that are made of "fuse" material. This "fuse" will open on any overload, so that any short in the B supply will open the rectifier cathode instead of blowing the house fuses. Also, this serves to protect the receiver from excessive damage. At the same time, this means that current surges will at times open the tube's fuse link, thus ruining the rectifier.

To avoid this, the circuit shown in Fig. *11* has the pilot lamp arranged so that, if too high a plate current surge occurs, the lamp will burn out, effectively increasing the resistance in the rectifier plate circuit. This will often prevent the tube from burning out, too.

A fairly high plate current surge occurs while the input filter condenser charges when the set is first turned on; a considerably larger one—large enough to burn out both the pilot lamp and the rectifier—may result if you snap the set off, leave it off long enough for the charge on the input filter condenser to leak off, then snap the set back on while the rectifier is still warm. Remember—NEVER snap an a.c.-d.c. set off and on.

On a set of this kind, if you find the pilot lamp is burned out, replace it. If the replacement burns out, either there is a short circuit across the B supply, or the tapped section of the rectifier filament is open. If the lamp burns normally, then the original was probably burned out by one of these current surges.

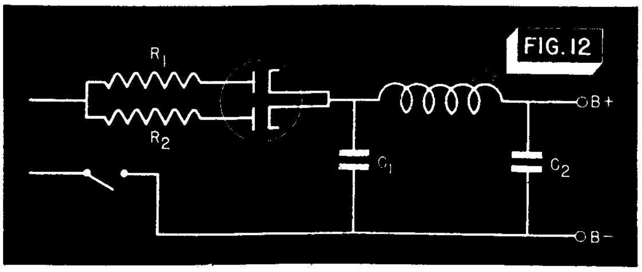
Except for the tapped filament, and the fact that the tubes are chosen so that their filament voltage values add up to the line voltage value, the circuit in Fig. *11* is much like those previously shown.

Incidentally, some of the earlier sets have 25- to 50-ohm resistors in series with the plates of the rectifier, as shown in Fig. *12*. These resistors protect the rectifier; if the surge current is high, the voltage drop across the resistors lowers the rectifier plate voltage to such an extent that the cathode links are not likely to open.

REPLACING FILTER CONDENSERS

Electrolytic condensers are more likely to become defective than any other part in an a.c.-d.c. receiver. Because of space limitations, they are usually grouped in

FIG. 12



a single block or container. When one condenser in such a unit becomes defective, replace the entire unit; the other sections are very likely to fail soon.

Of course, if you obtain an exact duplicate condenser, its replacement is simple. Often, however, these condensers have no identifying markings, and there may be no service information for the set. You must then find out what is in the block before you get a replacement.

First, make a sketch of the old condenser block, showing all of the leads. Trace each of these leads in the receiver and determine what power pack circuit is used. Then draw in what you believe to be the internal connections for the condenser block, and mark the polarity of each lead. Next, determine the approximate capacity values from the following list:

Input Filter Condenser. Any value between 10 and 20 mfd., rated at 150 volts or higher. Values up to 40 mfd. are used, but only if there is a protective resistor of some sort in the rectifier plate circuit.

Output Filter Condenser. Any value between 16 and 40 mfd., rated at 150 volts or higher.

Loudspeaker Field-Coil Filter Condenser. Any value between 4 and 10 mfd., rated at 150 volts or higher.

Output-Tube Cathode By-Pass Condenser. Usually between 5 and 25 mfd., rated at 25 or 50 volts.

With these suggestions for possible values, you can try to get a single replacement block. If you cannot find such a replacement, you may be able to get a block to replace some sections and use individual midget electrolytics for the rest. However, be very careful to get condensers that will fit the available space.

In many cases, the two filter condensers are in a common unit, and the by-pass condenser for the cathode of the output tube is a separate unit. When ordering a dual replacement condenser for the filter, remember that they are made in three different types. The ones shown in Figs. *13A* and *13B* have a common lead from the two sections. That shown in *A* has a common negative lead, that in *B* has a common positive lead. These condensers are not interchangeable, but either can be replaced by the unit shown in Fig. *13C*, in which all positive and all negative leads are brought out.

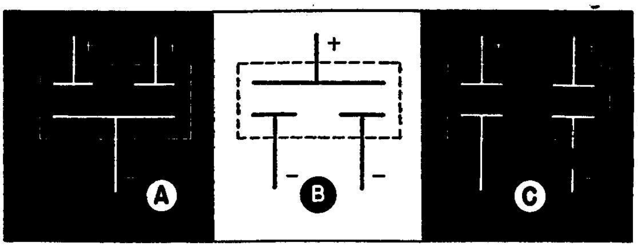
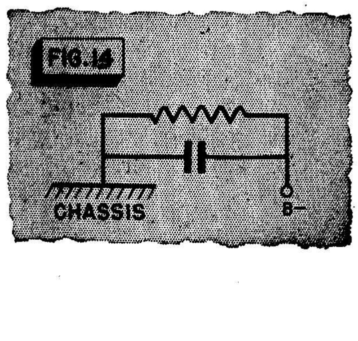


FIG. 13. The dotted lines represent the condenser cases. In the types shown at *A* and *B*, the two condensers are tied together inside the case so that a "common" lead is obtained. You can replace these with exact duplicates, or else you can use the general replacement type, shown at *C*, by connecting together the proper pair of leads.

CHASSIS GROUNDS

In some a.c.-d.c. receivers, the chassis is connected to B—, and thus to one side of the power line. However, most sets do not have this connection, because, if the power cord wire (that connects to B—) happens to be plugged into the hot (ungrounded) terminal of the wall receptacle, the chassis will then be above ground potential. If you touch the chassis while you are grounded, you will get a shock; if the chassis itself becomes grounded, the house fuses will be blown. (For this reason, never connect a ground to an a.c.-d.c. receiver, and be sure these receivers never touch a ground accidentally.)

To avoid this trouble, many a.c.-d.c. receivers have the arrangement shown in Fig. *1*. Here, all points shown as "grounded" are connected by *wire* to B—, which is connected to the chassis only through condenser C_1. (The chassis, in this instance, has the special symbol you will find at the lower center of the diagram.) In some sets, the connection between B— and the chassis is made through the resistor-condenser combination shown in Fig. *14*.



When the chassis is not used as B—, the tuning condenser may or may not be insulated from the chassis.

If not, the connection between the tuning condenser and B— is completed through the by-pass condenser that connects the chassis to B—.

Remember, then, that you will often be unable to use the set chassis as the B— test point when making voltage and continuity tests in an a.c.-d.c. set. For *continuity* tests, you can always use one side of the power line for your B— reference point. To do so, unplug the power cord, hold one test probe across both prongs of the plug, and turn ON the on-off switch. This will connect your probe to B—. Your other test probe can then be used in the usual manner for making continuity tests in the radio.

If you are making voltage measurements, the set will be turned on anyway, so locate any point in the B— circuit that is convenient. A filter condenser terminal, or either side of the on-off switch, is usually the most convenient point to use.

► Either the cathode of the rectifier or the screen grid of the power tube can be used as the B+ reference point.

GENERAL SERVICE INFORMATION

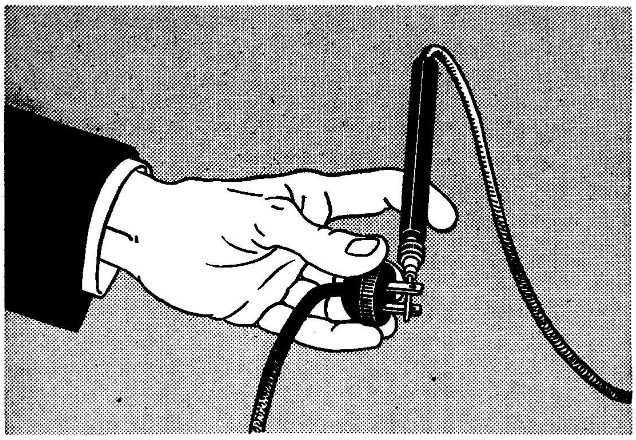
Now that you know the main features of a.c.-d.c. sets, let's see how to service them.

Remember that these sets are almost always very simple, so there is not much that can go wrong with them. In practically all cases, operating defects can be traced to a faulty electrolytic filter condenser, tube, or audio coupling condenser. If the complaint could be caused by any one of these, check it before trying the usual localizing procedures.

Now, let's see what to look for in specific complaints.

Dead Sets. First, determine if the pilot lamp lights. If it does not, the filament string may be open because of a burned-out tube, a burned-out pilot lamp (and its shunt resistor), or an open in the a.c. cord. Check each of these possibilities.

If the pilot lamp lights normally, and the set is dead, the cathode of the rectifier tube may be open—or there may be a short circuit across the supply terminals, such as would be caused by a leaky or shorted filter or by-pass condenser.



This sketch shows one way of holding a test probe on both prongs of a power cord plug. This method leaves the other hand free for making continuity tests.

The voltage at which an a.c.-d.c. receiver operates is low—between 90 and 120 volts. A defect that causes a drop of only 10 volts in the B supply voltage (a change that would go unnoticed in a 250-volt power supply of a straight a.c. set) may definitely affect the operation of an a.c.-d.c. receiver. For example, the lowered voltage may stop the oscillator, and thus kill the set.

A common cause of a lowered B supply voltage is a high power factor or an open in the input filter condenser. As you know, you check for either defect by shunting the suspected condenser with another of about the same capacity. If the symptoms clear up, the original condenser is defective and must be replaced.

► However, be careful when you make this test. An a.c.-d.c. rectifier tube can be ruined if you connect an uncharged test condenser across the input filter condenser with the set turned on. To prevent this, make a practice of charging the test condenser at the *output* of the filter, by connecting it across the output filter condenser, before you move it to the input terminals. The resistance of the choke will prevent an excessive surge current from flowing during this charging process, and if you place the condenser across the input filter con-

denser before it has time to discharge, it cannot draw a very high current in charging up to the full voltage across the input of the filter. Always remember this trick so you won't open the cathode of the rectifier.

► If you have d.c. power in your district, always watch for a reversed power plug. The rectifier tube will prevent current from flowing if the line polarity is wrong. The owner may be unaware of this. Try reversing the plug in the wall outlet before making other tests, particularly if the pilot lamp lights.

Distortion. A defective filter condenser that causes a drop in the B supply voltage is a common cause of excessive distortion. Other possibilities are an off-center voice coil, an unglued speaker cone, a leaky coupling condenser in the resistance-coupled amplifier, or gas in the output tube.

As you know, you can check for gas in the output tube and for leakage in the coupling condenser by measuring the voltage across the grid resistor R_1 as shown in Fig. *15*. Normally no d.c. voltage exists across this resistor. If you get a reading across R_1, the tube is gassy or the condenser is leaky. Unsolder one end of the condenser; if the voltage disappears, the condenser is leaky. Otherwise the tube is gassy.

If the distortion is accompanied by very low volume, suspect an open field coil. When the field is shunted across the power supply as in Fig. *7*, an open in the field will not affect the voltages applied to the tubes. However, the very low field excitation will cause distortion and low volume.

Low Volume. Defective filter condensers, an open speaker field, improper alignment, and a poor antenna system are the common causes of low volume in an a.c.-d.c. receiver.

If the antenna is one of the hank varieties, wound on a card, be sure it is completely unrolled and stretched out.

A more obscure trouble, peculiar to a.c.-d.c. sets, is the possibility of a partial short in a tube filament. The high-voltage filaments are made by folding the resistance wire back and forth a number of times. If one or two of these folds short together, the filament string will still be complete, but that one tube will not have its

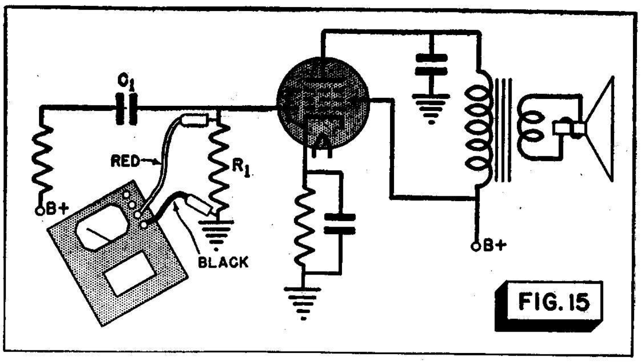


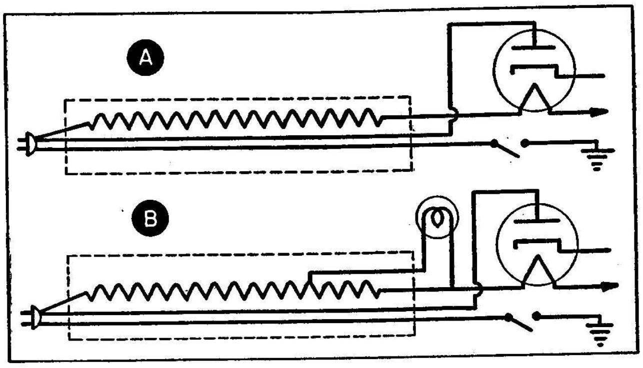
FIG. 15

cathode sufficiently heated to give normal plate current. This may reduce the volume. At the same time, it will raise the filament voltages on the other tubes in this string—some other tube in the string may even burn out as a result of the excessive filament voltage across it.

► If a set has a history of frequently burning out tubes, carefully measure the filament voltage across every tube in the string, watching particularly for one that has a voltage drop *lower* than normal for that kind of tube. If you find such a tube, be sure to replace it. Incidentally, a tube tester will not always show up a defect of this kind.

Oscillation. A certain amount of oscillation at high volume level is normal in some t.r.f. receivers. If turning the volume control to a lower setting stops the oscillation and allows the signals to come through clearly at normal volume, nothing should be done to the set for this condition. The regeneration is introduced to give better sensitivity. Of course, if the oscillation cannot be controlled, or if the volume must be reduced too much to eliminate it, look for a defect. The most common are an antenna that is not properly uncoiled, a misplaced control-grid lead, an open by-pass condenser, missing tube shields, or an open output filter condenser.

► If the complaint is that a superheterodyne whistles and squeals, check to see if an outside antenna is being used. Too long an antenna will load the preselector, reducing its selectivity, so that excessive station interference is heard.



Two styles of Cordohms are shown here. The standard is at *A*, and one tapped for a pilot lamp is shown at *B*. Occasionally, you will have to replace a Cordohm. If you have no information as to the resistance value, calculate it as you would a series filament resistor. As you know, the Cordohm was developed to dissipate the heat (that is, the result of the power loss in its resistance) into space. You are liable to get calls from alarmed receiver owners who have happened to touch the Cordohm and have found it warm. You can explain that this is natural. If you find the Cordohm "tucked away" inside a receiver cabinet, unfold it and pull it outside the cabinet so that it can properly dissipate heat. Warn the customer about this. You may even find that some owners have tried to shorten the cord by cutting it off. As they are usually unaware of the third wire, they rarely make the proper connections, so the set is usually dead. This cord cannot be shortened, because this will reduce its resistance, even if the proper connections are made.

Intermittent Reception. Experience has shown that the most common cause of intermittent trouble is a defective audio coupling condenser or a defective output tube.

Hum. As in standard a.c. receivers, the most frequent causes of hum are defective filter condensers and cathode-to-heater leakage. Be particularly careful about cathode-to-heater leakage in the output tube. High-voltage filaments are rather subject to this trouble.